Original Research

ENDOVASCULAR AV FISTULA SALVAGE IN PEDIATRIC PATIENTS: INITIAL EXPERIENCE AT IKDRC ITS

Dr. Ketul K Pathak[1*], Dr. Nidhi Popat[2], Dr. Rahul Mehta[3], Dr. Shahenaz Kapadia[4], Dr. Kinnari Vala[5], Dr. Anshuman Saha[6], Dr. Shuvro H Roy Chaudhuri[7]

[1*]Assistant Professor, Interventional Radiology, Department of Radiology, Gujarat Cancer Research Institute, Ahmedabad.
[2]Associate Professor, Department of Radiology, Institute of Kidney Diseases and Research Centre – Institute of Transplantation Sciences, Ahmedabad.
[3]Assistant Professor, Department of Radiology (Interventional radiology), Institute of Kidney Diseases and Research Centre – Institute of Transplantation Sciences, Ahmedabad.
[4]Associate Professor, Department of Pediatric Nephrology, Institute of Kidney Diseases and Research Centre – Institute of Transplantation Sciences, Ahmedabad.
[5]Associate Professor, Department of Pediatric Nephrology, Institute of Kidney Diseases and Research Centre – Institute of Transplantation Sciences, Ahmedabad.
[6]Associate Professor, Department of Pediatric Nephrology, Institute of Kidney Diseases and Research Centre – Institute of Transplantation Sciences, Ahmedabad.
[7]Director of Interventional Therapies, Department of Interventional Radiology, NH Group of Hospitals, India.
Corresponding Author: Dr Ketul K Pathak
Assistant Professor, Interventional Radiology, Department of Radiology, Gujarat Cancer Research Institute, Ahmedabad.

ABSTRACT

Early transplantation is the preferred treatment for children with end stage renal disease (ESRD); 30% of these patients still need hemodialysis (HD). In cases of arteriovenous fistula (AVF) failure, endovascular AVF salvage procedures hold promise for AVF salvage. These procedures have an established role in AVF failure in adult patients. In this study, we have performed similar endovascular AVF salvage procedures in pediatric patients and follow them for 1-year patency. Results showed, primary patency rate at 1-year post AVF salvage was 82%. We concluded that in pediatric patients, endovascular AVF salvage procedures help in case of AVF failure. It is helpful as preservation of a vascular access site and/or a bridge procedure until renal transplantation.

Keywords: Arterio Venous Fistula, Chronic Kidney Disease, Hemodialysis, Transplantation.

INTRODUCTION

Arterio Venous Fistula (AVF) is a lifeline for chronic kidney disease (CKD) patients on hemodialysis (HD). These AVF often fail because of thrombus, stenosis and/ or occlusion. Endovascular methods, which are well-established in literature for failed AVF salvage in adult patients, can also help salvage these AVF in pediatric patients. [1]

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Children and adolescents on hemodialysis aged 0-19 years with body mass index (BMI) of >20, who are not the candidates for renal transplant within the first year are strongly recommended by K-DOQI to have a permanent vascular access implanted. [2] In these patients, HD is started with a central venous catheter (CVC) in >90% of cases and a permanent catheter in >80% of cases, even though most pediatric HD patients fulfill the weight and timing criteria for insertion of permanent vascular access upon starting of HD. [3] The FFBI had such a positive impact on the adult HD population, that in 2005, the International Pediatric Fistula First Initiative (IPFFI) was launched to focus only on improving HD access for children and adolescents. [4]

To ensure that every functioning AVF has the best opportunity for longevity, the goal should be salvage of AVF failure or non-maturation as early as possible. [5] Many AVF, after their creation and while

being used for HD, show failure in the form of thrombus/ occlusion. AVF failure can be salvaged with a high expectation of success via endovascular methods, namely angioplasty. Multiple techniques of angioplasty are being employed to salvage the AVFs.[6] Endovascular techniques have proven to be very effective in managing problems related to AVF failure. [5] In this study, we evaluated the role of endovascular AVF salvage procedures in pediatric patients and followed the patients for 1-year patency.

MATERIALS AND METHODS

The present retro-prospective study was performed on all AVF created in pediatric population undergoing HD, aged 6 to 14 years at the Institute of Kidney Diseases and Research Centre – Institute of Transplantation Sciences (IKDRC – ITS) from 01/07/2021 to 01/07/2024. The Institutional Ethics Committee approved the study with approval number GUTS/5th EC/Approved/64/2023.

AVF failure in any patient was defined as inability to get HD done through AVF because of AVF stenosis/ occlusion and/ or thrombus. Primary (1°) AVF failure was defined as failure of AVF which was previously used for HD without any history of intervention. Secondary (2°) AVF failure was defined as failure of AVF in whom endovascular salvage procedures have been performed previously. AVF non-maturation was defined as inability of AVF to mature and start functioning after 6 weeks from its creation.

Inclusion Criteria:

- AVF failure in pediatric patients requiring HD
- AVF non maturation

Exclusion Criteria:

- Age > 16 years
- Loss of follow up
- Uncorrectable coagulopathy

Patient referred to Department of Interventional Radiology after AVF failure. Temporary HD access was placed and all these patients underwent HD 1 day prior to the procedure.

All the procedures were carried out under local anesthesia and sedation using either fluoroscopy or angiography suit by a single operator. In patients having AVF thrombus, percutaneous thrombolysis (PT) was done using Inj reteplase (rTPA, 1 IU) through direct puncture using a 24 G needle and 3 mm leur lock syringe under ultrasound (USG) guidance and all aseptic precautions. 2 hours dwell-time was given post injection of rTPA.

Vascular access was taken either in the form of radial artery (RA) or common femoral vein (CFV) under USG and fluoroscopy guidance. First preference was given to RA access in view of close proximity to AVF site, easier exchange of materials through sheath and shorter procedural times. CFV access was used when RA access could not be taken because of very thin caliber (<1.5 cm). 6 Fr thin walled sheath was used for the access (10 cm length for RA and 45-60 cm length via CFV access). Unfractionated heparin (18 mg/ kg) was administered via sheath post vascular access.

Fistulogram was done from sheath to identify the level of stenosis/ occlusion using inj iohexol. Level of block (stenosis/ occlusion) was documented. 0.035” 260 cm hydrophilic guidewire and 5 Fr catheter combination was used for crossing the AVF.

In patients who underwent RA access, guidewire was crossed from RA to brachial artery (BA) to AVF to brachiocephalic vein (BCV) to superior vena cava (SVC) and then to inferior vena cava (IVC). 0.035” 260 cm J tip extra stiff amplatz guide wire was exchanged with hydrophilic guide wire with its tip placed in IVC.

In patients who underwent CFV access, the guidewire was crossed from IVC to SVC to BCV to AVF to BA. 0.018” 300 cm guidewire was exchanged with hydrophilic guide wire with its tip placed in BA.

Rendezvous technique was used in patients with impossible RA access and inability to cross 0.035” hydrophilic guide wire via CFV access (through BCV) into distal part of AVF because of tight occlusion in the distal most part of AVF. AVF was punctured (antegrade) using 18 G puncture needle and 0.035” 260 cm J tip hydrophilic guide wire was crossed into IVC which was snared via CFV sheath. Catheter was then advanced from CFV end towards AVF till AVF puncture site. Hydrophilic guide wire was removed and then inserted from CFV access and crossed into BA, which was exchanged with 0.018” 300 cm guidewire. AVF puncture site was manually compressed for 5 min.

AVF angioplasty was done using percutaneous transluminal angioplasty (PTA) balloons according to size of the native AVF (30% upsize with respect to diameter of draining vein of AVF measured on USG). PTA balloons which were used had diameter of 4/5/6 mm and lengths varying from 60 to 100 mm. Pressure at which the waisting was relieved was documented.

Post angioplasty, fistulogram was done to confirm the restoration of flow across AVF and to look for any residual stenosis/ thrombus/ hematoma formation. The sheath was removed when fistulogram was found to be satisfactory. Access site was closed using manual compression in all cases.

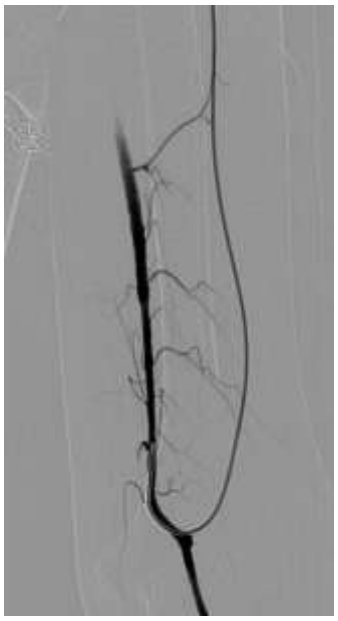

Figure 1: DSA Angiography of BCF in a paediatric patient. Tip of the catheter placed in Brachial artery, the angiogram show total occlusion of BCF with no flow in AVF.

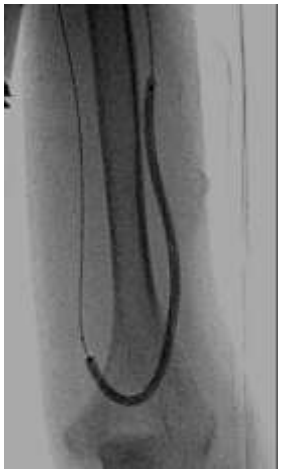

Figure 2: Guidewire was placed in Brachial artery and angioplasty was done using PTA balloon. Here we can see PTA balloon from Brachial artery to AVF.

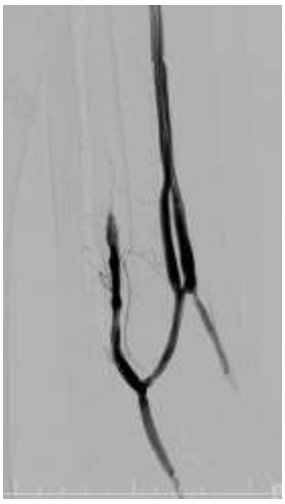

Figure 3: Post angioplasty DSA Angiogram shows restoration of flow in AVF.

Post compression, low molecular weight heparin (LMWH) was administered in dosage of 1 mg/ kg. Patients were started single anti platelet therapy (Ecosprin 75 mg) from the next day. HD was started after 2 days in all these patients.

Details including age of the patient, type of AVF, time since AVF creation, type of AVF failure/ non-maturation, details regarding stenosis/ occlusion, site of stenosis, presence of thrombus, type of access site used, pressure at which waisting was relieved during angioplasty etc were documented. AVF cannulation for HD was done after 2 days of AVF salvage. HD catheter was removed after AVF cannulation.

All the data analysis was performed using IBM SPSS ver. 25 software. Quantitative data were expressed as mean and standard deviation, whereas categorical data were expressed as proportions.

RESULTS

During the study period, 15 endovascular AVF salvage procedures were performed on 13 patients. 2 patients required repeat procedure because of 2° AVF failure. The mean age of the study population was 10.46 years (range, 6 - 14 years). Majority of the patients were male [n =8, (61%)], rest are females [n=5, (39%)].

In majority number of patients, [n = 7, (54%)] left side AVF was observed, whereas, in other subset of patients, [n = 6, (46%)] right side AVF was observed. The majority patients had undergone brachiobasilic fistula (BBF) [n = 6, (46%)] and brachiocephalic fistula (BCF) [n = 6, (46%)], whereas only 1 patient had Radio cephalic fistula (RCF) [n = 1, (8%)].

The mean time from AVF creation to AVF failure was 3.1 month (range, 1-8 months). In patients with AVF non maturation, intervention was done at 6 weeks post AVF creation (to reduce the chances of anastomosis give away during angioplasty). All the

primary AVF failure patients presented within 1 week of AVF failure.

For documentation of location of stenosis/ occlusion, AVF was arbitrarily divided into 3 equidistant parts, proximal, mid and distal AVF, proximal part being near anastomosis. In majority of patients, stenosis was reported in the mid AVF [n = 8, (62%)], followed by distal AVF [n = 3, (23%)]. and then proximal AVF [n = 2, (15%)]. Thrombus was reported in 6 (46%) patients. All patients with thrombus received PT using IV reteplase (mean dose 1 IU).

Table 1: Comparing the type of AVF with the place of stenosis

Stenosis details	Type of AVF			
	BBF	BCF	RCF	
Mid AVF	2 (33)	5 (83)	1 (100)	8 (62)
Distal AVF	3 (50)	0 (0)	0 (0)	3 (23)
Proximal AVF	1 (17)	1 (17)	0 (0)	3 (23)
Total	6 (100)	6 (100)	1 (100)	13 (100)

Data are expressed as the number of patients (percentage). BBF: brachio basilic fistula; BCF: brachiocephalic fistula; RCF: radio cephalic fistula.

RA and CFV access were taken in 6 (46%) and 7 (54%) patients respectively. Rendezvous technique was used in 2 patients. The mean pressure at which waisting could be relieved was 19.4 atm (range, 12 – 38 atm). The highest pressure at which waisting was relieved was 38 atm using ultra non-compliant balloon, which was in a 14 years old girl.

Non maturing AVF underwent Balloon-assisted maturation (BAM) in 4 (30.7%) patients and was more common in BCF followed by BBF.

No minor/ major complications were observed during these procedures.

All the patients underwent follow up at 6 months and 1 year interval and patency rates were calculated.

Primary patency rate at 1-year post AVF salvage was 82% (2 patients expired during the follow up because of reasons unrelated to the procedure, they were excluded from calculation of patency rates). In 2 (18%) patients, AVF failure was observed after 6 months of AVF salvage. Both of them underwent repeat angioplasty for AVF salvage. The secondary patency rate at 1 year post AVF salvage was 100%.

DISCUSSION

Providing vascular access care for HD to children and adolescents with the end-stage renal disease remains a contentious area of medicine. Various national and international guidelines provide therapeutic and decision-making pathways for adult patients. [7, 9] Early AVF failure/ non maturation must be salvaged. [5, 6] Endovascular techniques have proven to be very effective in managing these issues. Current study is the first of its kind in Indian pediatric population evaluating the role of endovascular AVF salvage procedures.

According to the U.S. National Kidney Foundation, AVF should be the first choice for vascular access in patients weighing over 20 kg. However, there is no such recommendation for the Indian population. [2] In Indian patients, most pediatric HD patients are treated with a central venous catheter (CVC). At our institute, we advocate the use of AVF for HD in all patients if feasible. Instead of creating a new AVF every time when a previously placed AVF fails, we have done endovascular salvage whenever possible. This was possible because of interdisciplinary planning and early intervention in the form of endovacular AVF salvage. Primary patency rates 1-year post AVF salvage was 81.8% without any major complications. Brittinger et al. reported over 90% complication-free function of AVF in all age groups above 6 months in 784 pediatric patients. [9] Our study did not observe any complications.

BAM was done in 30.7% of patients and was more commonly done for BCF, followed by BBF. Two deaths were reported in the follow up of present study; from causes unrelated to the procedure, approximately 8 and 10 months post procedure (one because of sepsis and other one because of cardiac complications). They were excluded from the study while calculating patency rates.

Falk et al. reported that performing percutaneous interventions can promote maturation and maintain patency of AVF (n=146; median age 66 years). Nevertheless, only 74% of non-maturing fistulas matured into functioning ones, despite many procedures to promote maturation. [10] George et al. studied 119 patients (mean age 57 ± 14 years) with AVF failing to mature, who underwent fistulogram, stenotic lesions underwent balloon angioplasty and accessory veins underwent obliteration. The study reported that the technique was successful in 89.9%, and the AVF was salvaged in 83.2%, confirming that endovascular treatment holds promise to salvage (determined by successful use during HD) these AVF. [11]

Our findings, supported by previous studies, showed that AVFs have a high salvage rate after endovascular AVF salvage. However, success rates revealed in the present study are comparable but modestly lower than those reported by previous studies [12,3] in their series on early AVF failure. This difference may relate to disease severity.

There is much paucity of literature available for endovascular AVF salvage in pediatric patients. Here in this case series, we have shared our protocol of these procedures and patency rates.

Cross-sectional nature, non-randomization, and single center are the few limitations of the present study; there is need for a large randomized clinical

trial to provide more strength to the current study experience.

CONCLUSION

In pediatric patients, endovascular salvage of AVF can help in case of AVF failure or non-maturation, which in turn helps lowering morbidity related to CVC catheters. The results of our study series are comparable to adult age group. These procedures are safe and effective.

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